

PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION  
International Bureau



INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification <sup>6</sup> : <b>H04R 1/34, G06F 1/16</b>		A1	(11) International Publication Number: <b>WO 98/43464</b> (43) International Publication Date: <b>1 October 1998 (01.10.98)</b>		
(21) International Application Number: <b>PCT/GB98/00834</b>		(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, GM, GW, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).			
(22) International Filing Date: <b>19 March 1998 (19.03.98)</b>					
(30) Priority Data: 9705981.0 22 March 1997 (22.03.97) GB					
(71) Applicant (for all designated States except US): NEW TRANSDUCERS LIMITED [GB/GB]; Stonehill, Huntingdon, Cambridgeshire PE18 6ED (GB).					
(72) Inventors; and		Published			
(75) Inventors/Applicants (for US only): AZIMA, Henry [CA/GB]; 3 Southacre Close, Chaucer Road, Cambridge CB2 2TT (GB). COLLOMS, Martin [GB/GB]; 22 Burgess Hill, London NW2 2DA (GB). CROCKER, Norman [GB/GB]; 70 Townsend Lane, Harpenden, Hertfordshire AL5 2RG (GB). ROBERTS, Martin [GB/GB]; 17 Home Farm Lane, Bury St. Edmunds, Suffolk IP3 2QJ (GB).		With international search report.			
(74) Agent: MAGUIRE BOSS; 5 Crown Street, St. Ives, Cambridgeshire PE17 4EB (GB).					
<b>(54) Title: PERSONAL COMPUTING DEVICES COMPRISING A RESONANT PANEL LOUDSPEAKER</b>					
<b>(57) Abstract</b>					
The invention is a lap-top computer (128) or the like personal computing device having a body (137) comprising a keyboard (138) and a lid (130) hinged to the body and comprising a display screen (129) characterised by a resonant panel loudspeaker, preferably a distributed mode acoustic radiator loudspeaker, in or attached to the lid, and an acoustic waveguide or horn (167, 168) directing an acoustic output from the loudspeaker in a desired direction.					

**FOR THE PURPOSES OF INFORMATION ONLY**

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	ES	Spain	LS	Lesotho	SI	Slovenia
AM	Armenia	FI	Finland	LT	Lithuania	SK	Slovakia
AT	Austria	FR	France	LU	Luxembourg	SN	Senegal
AU	Australia	GA	Gabon	LV	Latvia	SZ	Swaziland
AZ	Azerbaijan	GB	United Kingdom	MC	Monaco	TD	Chad
BA	Bosnia and Herzegovina	GE	Georgia	MD	Republic of Moldova	TG	Togo
BB	Barbados	GH	Ghana	MG	Madagascar	TJ	Tajikistan
BE	Belgium	GN	Guinea	MK	The former Yugoslav Republic of Macedonia	TM	Turkmenistan
BF	Burkina Faso	GR	Greece			TR	Turkey
BG	Bulgaria	HU	Hungary	ML	Mali	TT	Trinidad and Tobago
BJ	Benin	IE	Ireland	MN	Mongolia	UA	Ukraine
BR	Brazil	IL	Israel	MR	Mauritania	UG	Uganda
BY	Belarus	IS	Iceland	MW	Malawi	US	United States of America
CA	Canada	IT	Italy	MX	Mexico	UZ	Uzbekistan
CF	Central African Republic	JP	Japan	NE	Niger	VN	Viet Nam
CG	Congo	KE	Kenya	NL	Netherlands	YU	Yugoslavia
CH	Switzerland	KG	Kyrgyzstan	NO	Norway	ZW	Zimbabwe
CI	Côte d'Ivoire	KP	Democratic People's Republic of Korea	NZ	New Zealand		
CM	Cameroon			PL	Poland		
CN	China	KR	Republic of Korea	PT	Portugal		
CU	Cuba	KZ	Kazakhstan	RO	Romania		
CZ	Czech Republic	LC	Saint Lucia	RU	Russian Federation		
DE	Germany	LI	Liechtenstein	SD	Sudan		
DK	Denmark	LK	Sri Lanka	SE	Sweden		
EE	Estonia	LR	Liberia	SG	Singapore		

## 5 PERSONAL COMPUTING DEVICES COMPRISING A RESONANT PANEL LOUDSPEAKER

10

DESCRIPTION

15

TECHNICAL FIELD

The invention relates to personal computing devices and more particularly to lap-top and the like portable personal computers, e.g. so-called note-book computers and portable personal telephones incorporating loudspeakers.

20

BACKGROUND ART

Embodiments of the present invention use members of nature, structure and configuration achievable generally and/or specifically by implementing teachings of our International application WO97/09842. Such members thus 25 have capability to sustain and propagate input vibrational energy by bending waves in operative area(s) extending transversely of thickness often but not necessarily to edges of the member(s); are configured with or without

anisotropy of bending stiffness to have resonant mode vibration components distributed over said area(s) beneficially for acoustic coupling with ambient air; and have predetermined preferential locations or sites within 5 said area for exciter means, particularly operationally active or moving part(s) thereof effective in relation to acoustic vibrational activity in said area(s) and signals, usually electrical, corresponding to acoustic content of such vibrational activity.

10 Members as above are herein called distributed mode acoustic radiators and are intended to be characterised as in the above PCT application and/or otherwise as specifically provided herein.

This invention is particularly concerned with acoustic 15 devices in the form of loudspeakers for personal computing devices, and with personal computing devices incorporating such loudspeakers.

#### DISCLOSURE OF INVENTION

The present invention is a lap-top or the like 20 portable computing device having a body comprising a keyboard and a lid hinged to the body and comprising a display screen, characterised by a resonant panel loudspeaker, preferably a distributed mode acoustic radiator loudspeaker, in or attached to the lid, and an 25 acoustic waveguide or horn directing an acoustic output from the loudspeaker in a desired direction. The desired direction will normally be towards the user of the portable computing device.

The waveguide or horn may comprise a member movably mounted on the lid, e.g. for pivoting and/or sliding movement, from a closed or retracted position to an advanced or open position. An opposed pair of the 5 waveguides or horns may be provided, e.g. to provide multi-channel acoustic output. The waveguide(s) or horn(s) may comprise a plate-like member hinged to the lid.

The lid may be provided with one or more acoustically transparent apertures in its outer surface.

10

#### BRIEF DESCRIPTION OF DRAWINGS

The invention is diagrammatically illustrated, by way of example, in the accompanying drawings, in which:-

Figure 1 is a front perspective view of a first embodiment of lap-top computer according to the present 15 invention;

Figure 2 is a cross-sectional view of the lid of the laptop computer;

Figures 2a and 2b are respective enlarged scrap cross-sectional side views of alternative details in the 20 embodiment of Figures 1 and 2;

Figure 3 is a front perspective view of a second embodiment of laptop computer;

Figure 3a is a plan view of the lid of the laptop computer of Figure 3;

25 Figure 4 is a front perspective view of a third embodiment of laptop computer;

Figure 5 is a front perspective view of an embodiment of electronic personal organiser;

Figures 5a and 5b are respective enlarged scrap cross-sectional side views of alternative details of the embodiment of Figure 5, and

Figure 6 is a rear perspective view of the embodiment 5 shown in Figure 5.

BEST MODES FOR CARRYING OUT THE INVENTION

Figures 1, 2 and 2a illustrate a lap-top personal computer (128) having a body (137) comprising a keyboard (138) and a lid (130) having a rectangular frame (1), e.g. of moulded plastics, supporting a visual display screen 5 (129) and which lid is hinged to the body for movement as indicated by arrow X, between a folded position in which the lid encloses the keyboard and an erect position in which the lid is substantially upright.

The lid (130) houses an opposed pair of loudspeakers 10 to adapt the computer for multi-media applications and the like, the loudspeakers each comprising a thin rectangular panel (2) forming a multi-mode acoustic radiator of the kind described in WO97/09842. Each loudspeaker panel (2) has a monolithic structure and is supported near to its 15 periphery on discrete resilient suspension elements (3) e.g. of an elastomeric material, which in turn are supported on the surrounding frame (1) via the display screen (129). A vibration exciter (9) is mounted on each panel at a predetermined position as discussed more fully 20 in our International application WO97/09842, to launch bending waves into each of the panels (2) to cause them to resonate to produce acoustic outputs. The excitors may be

electrodynamic.

The lid (130) comprises an opposed pair of cover members (167,168) which together define the outer casing of the lid and are each shaped as a flat rectangular panel 5 having a downturned peripheral rim extending round three adjacent sides, the fourth side being arranged to abut against the corresponding side of the opposite cover member. The cover members slide and hinge on the frame (1) in the directions indicated by arrows Y and Z respectively 10 such that when extended from the closed position indicated at the left-hand side in Figure 2 to their operative position indicated in Figure 1 and the right-hand side in Figure 2, they are locked by friction or other means to form acoustic waveguides or horn structures whose apertures 15 (169) are presented to the opposite sides of the lid. The horn expansion effectively begins over the region of the loudspeakers. The diffuse sound energy and nearly constant power with frequency of the loudspeakers means that relatively good matching is achieved between the horn and 20 the speaker elements. Benefits include relatively high acoustic efficiency, improved low range response and a sound directivity which is beneficially directed towards the user with reduced leakage towards others. The relatively small effective acoustic sources represented by 25 the horn apertures (169) also will improve the sense of stereo image localisation for the user.

It might also be possible to incorporate the multi-mode speaker units in the lid cover members (167,168) where

the radiation may then either be bi-directional and/or forwards directed via the horn structure.

As shown in Figure 2b it is possible to render the cover members (167,168) acoustically transparent by 5 providing apertures (170) therein, the apertures being coverable by a sliding grille (17) to allow sound from the speaker to exit, or alternatively acoustically opaque when the grille is moved to cover the apertures, to direct the sound through and only through the horn element. The 10 sliding grille would allow the user to open, or partially open and close the apertures to control the degree or mix of the horn effective component and the direct sound emitted via the grille.

Figures 3 and 3a show a second embodiment of laptop 15 computer which is generally similar to that described above with reference to Figures 1 and 2. However the complexity of the waveguide or horn mechanism is simplified, as compared to the embodiment of Figure 1 and 2 so that opposed horn/waveguide elements are provided by the wedge 20 shapes formed between flat plate elements (40) hinged by hinges (34) to the outer surface of a generally conventional lid (131) and the lid itself. In this embodiment, the elements (40) are or comprise multi-mode acoustic radiators of the kind described in WO97/09842 and 25 excited by vibration excitors (9) mounted thereon. The hinges (34) may have friction or detent action to allow both predetermined and/or user-preferred angles for the waveguide elements. Additionally the lid casing itself may

be adapted to resonate according to distributed mode principles by control of effective area geometry and exciter position.

The embodiment of Figure 4 is generally similar to 5 that of Figure 3, but in this case, the generally conventional lid case (131) of the laptop computer is provided with a single plate-like cover (40) hinged to the body (137), to form a wedge-shaped cavity to provide horn-like loading for a multi-mode speaker (2) located within 10 the cover.

The plate-like cover (40) is formed with a rectangular frame (41) supporting a distributed mode acoustic radiator panel (2) which may be bi-directional or forwards directed according to the required acoustic efficiency and desired 15 use. This plate-like cover may be single or multi-channel according to the properties of the plate and the location and number of excitors. Distributed mode speaker panels lend themselves to activation by multiple excitors due to the non-pistonic bending wave operation.

20 In the embodiment of Figures 5 and 6, the concept of the acoustic wave guide as described above is applied to distributed mode speaker(s) in the lid (150) of a personal digital assistant or personal data unit (158). The device (158) is generally similar to the laptop computer described 25 above and comprises a body (157) having a keyboard (156) and a lid (150) hinged to the body and incorporating a visual display screen (129). The lid construction is similar to that described above with reference to Figures

2 and 2a or 2b, as indicated in Figures 5a and 5b, with the exception that in the present case the lid cover (155) is a fixed structure having a plate-like surface surrounded by a downturned peripheral lip and which carries a frame (1) 5 supporting the display screen (129) with a resonant panel loudspeaker (2,9) resiliently mounted thereon. A pair of slots (159) are defined between opposite sides of the visual display screen (129) and the cover (155) which are coupled to an acoustic channel leading to the loudspeaker 10 region and which directs sound towards the user. Optionally as shown in Figures 5b and 6, the lid casing may be perforated at (170) to allow sound to be radiated from the rear section, under the control of a movable grille (171). The diffuse radiation characteristic and bi- 15 directional nature of the distributed mode speaker lends itself to the effectiveness of this application in the suggested mode of operation.

Where a personal data unit has audio modes of operation or may be combined with or associated with a 20 mobile telephone, the relatively large distributed mode-type speaker installed in the lid provides a means for hands free communication and also will be effective for loudspeaking tele-conferencing.

The lid cover (155) may also be designed as an 25 integrated distributed mode speaker or speakers if desired.

CLAIMS

1. A personal computing device having a body comprising a keyboard and a lid comprising a display screen hinged to the body to cover the keyboard, characterised by a resonant 5 panel loudspeaker in or attached to the lid, and an acoustic waveguide or horn to direct acoustic output from the loudspeaker.
2. A personal computing device according to claim 1, characterised in that the waveguide or horn comprises a 10 member mounted on the lid.
3. A personal computing device according to claim 2, characterised in that the member is movably mounted on the lid from a closed or retracted position to an advanced or open position.
- 15 4. A personal computing device according to claim 2 or claim 3, characterised in that the member forms a lid cover.
5. A personal computing device according to any preceding claim, characterised in that the loudspeaker panel is 20 supported in the lid by means of a resilient suspension.
6. A personal computing device according to claim 5, characterised by a frame surrounding the panel and on which the panel is suspended.
7. A personal computing device according to claim 6, 25 characterised in that the display screen is supported on the frame and in that the loudspeaker panel is resiliently supported on the display screen.
8. A personal computing device according to any one of

claims 2 to 7, wherein the cover is or comprises a resonant panel loudspeaker.

9. A personal computing device according to any preceding claim, characterised by an opposed pair of the waveguides 5 or horns.

10. A personal computing device according to any preceding claim, characterised in that the waveguide or horn comprises a plate-like member hinged to the lid.

11. A personal computing device according to any preceding 10 claim, characterised in that the lid is provided with one or more acoustically transparent apertures.

12. A personal computing device according to claim 11, characterised by a movable grille to adjust acoustic output through the apertures.

15 13. A personal computing device according to any preceding claim, characterised in that the resonant panel loudspeaker is integral with the lid.

14. A personal computing device according to any preceding 20 claim, characterised in that the resonant panel loudspeaker comprises a stiff lightweight panel having a monolithic structure.

15. A personal computing device according to any preceding claim, characterised in that the resonant panel loudspeaker is a distributed mode acoustic radiator.

FIG. 1

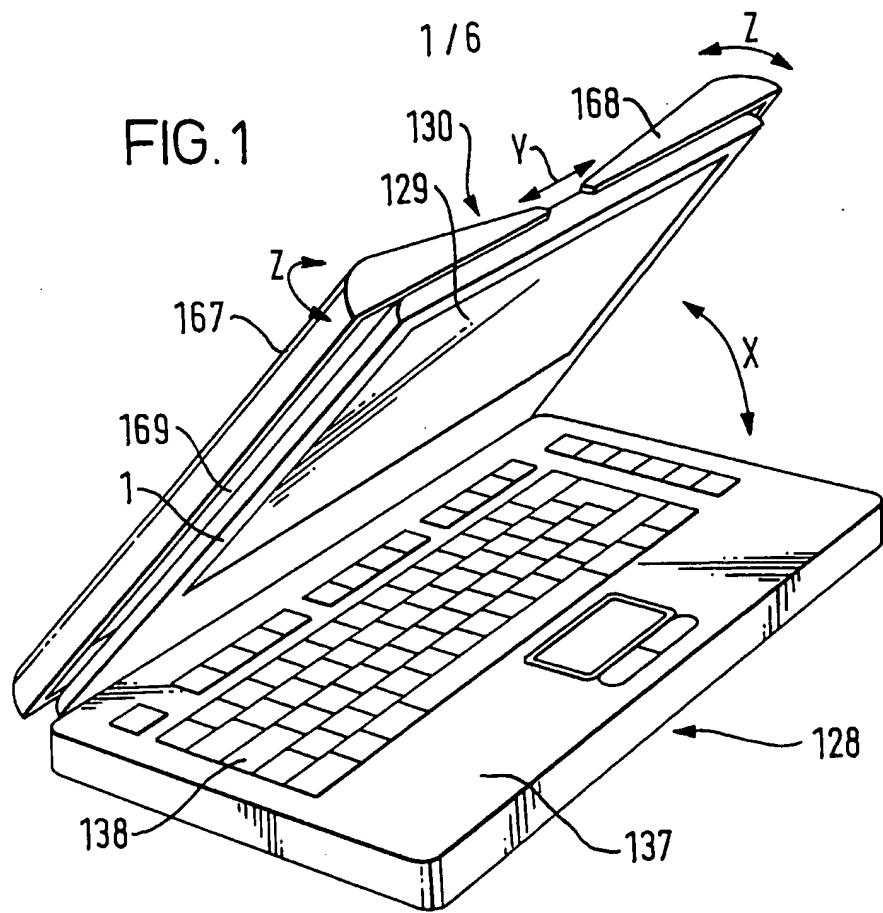
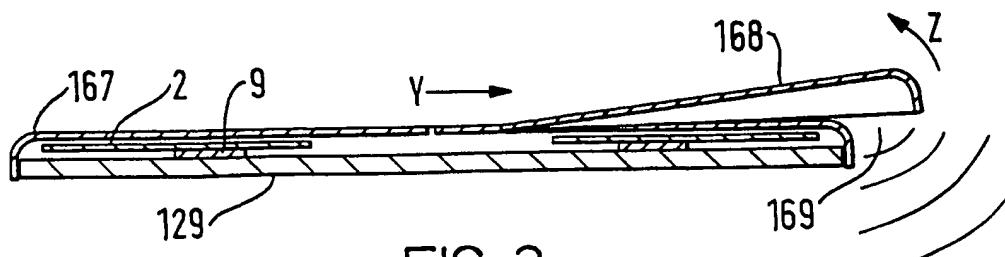
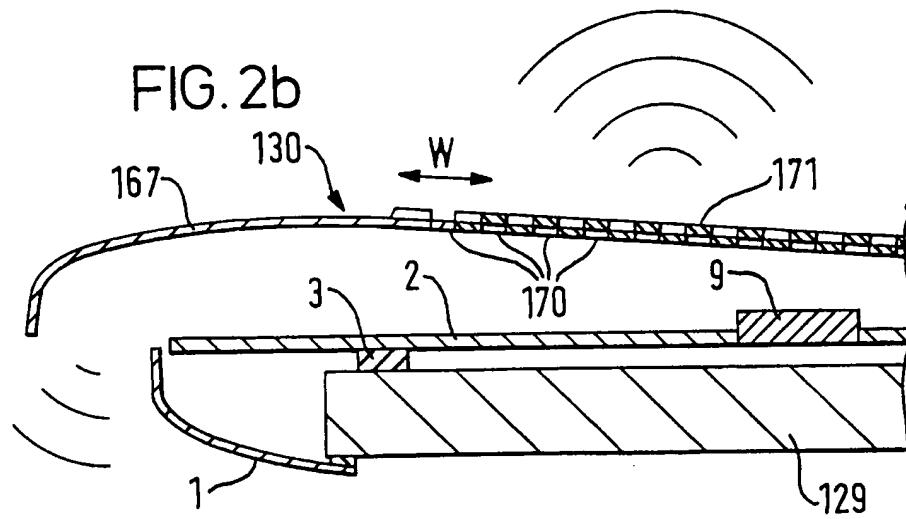
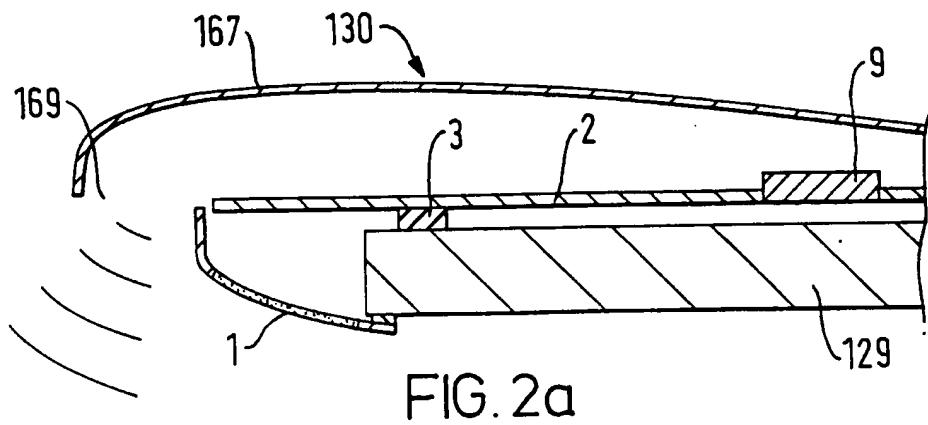


FIG. 2



2 / 6



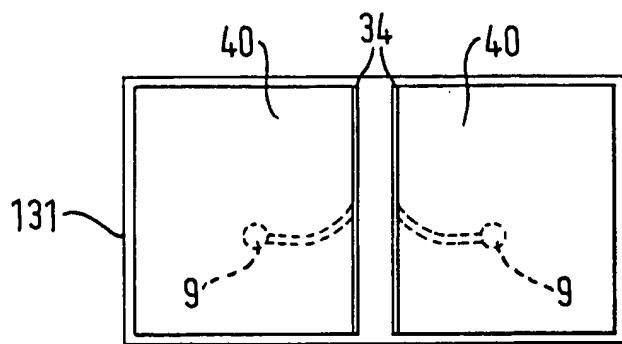
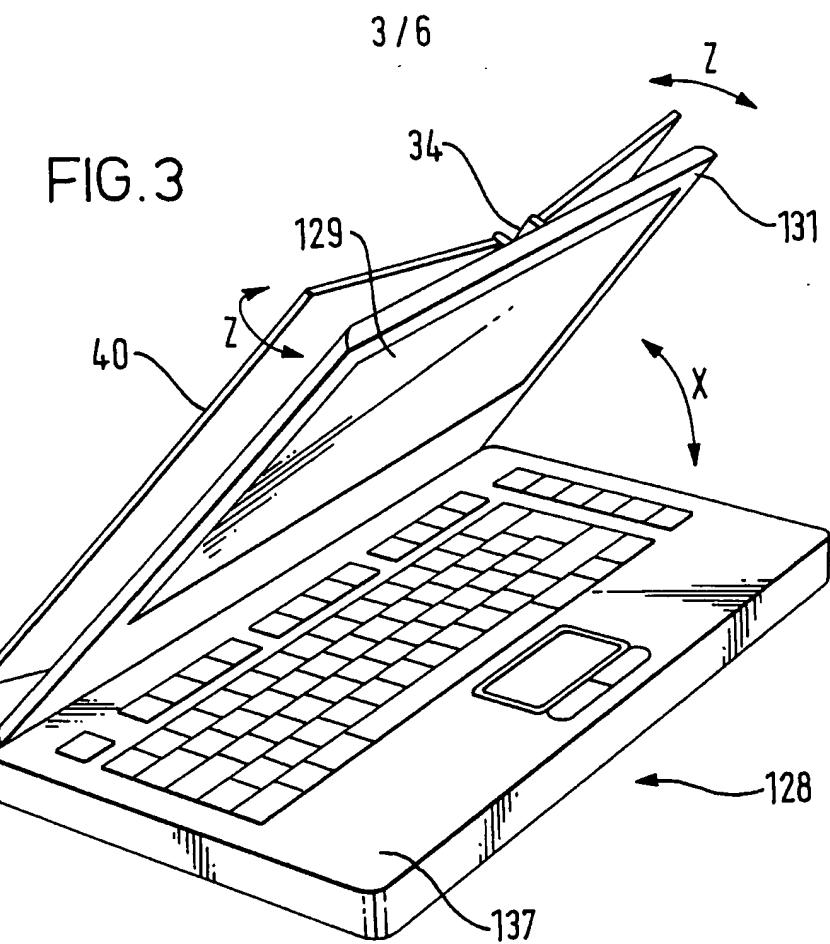


FIG. 3a

4/6

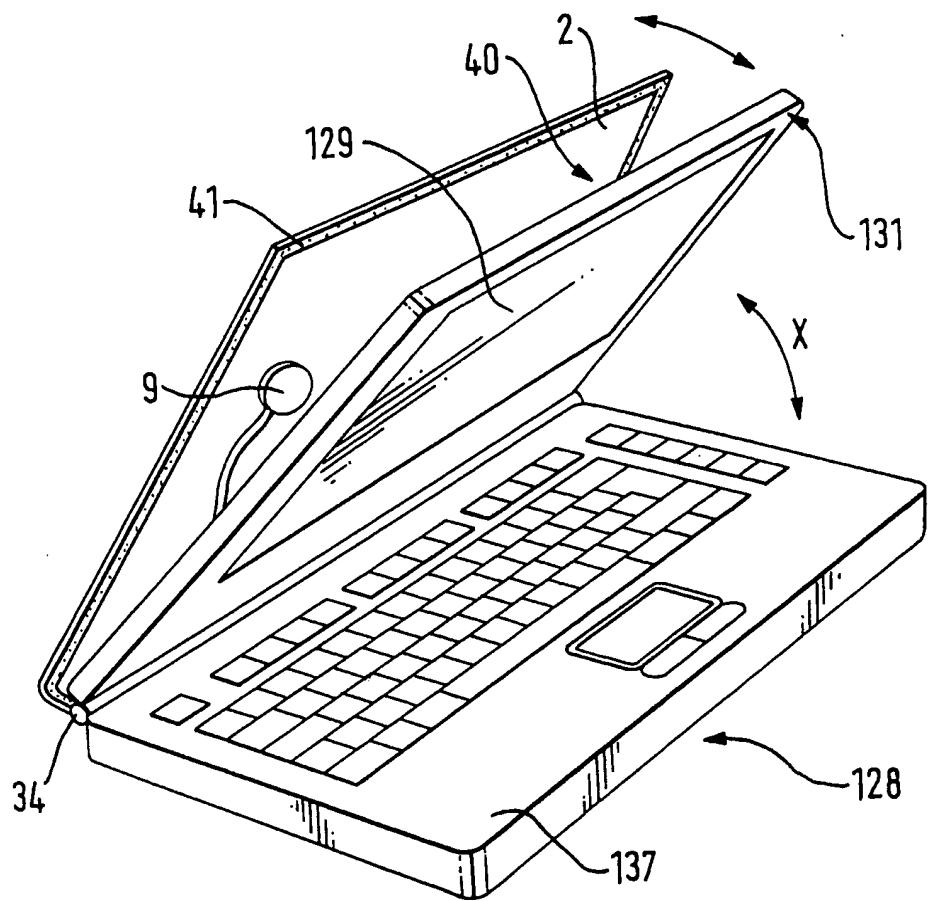
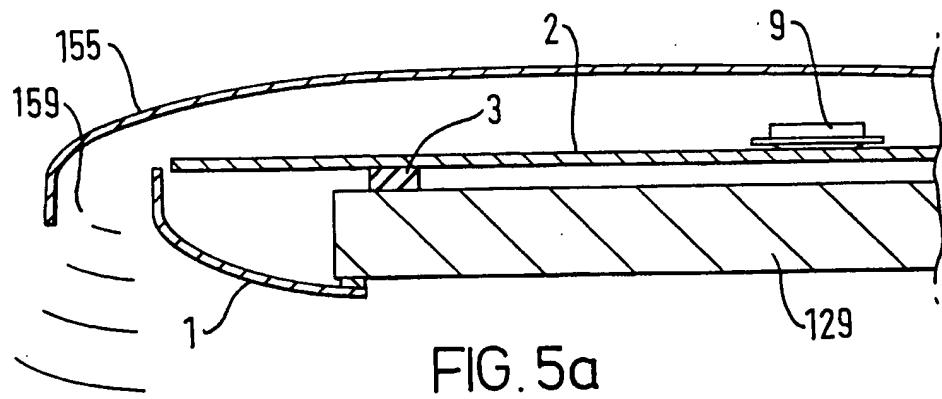
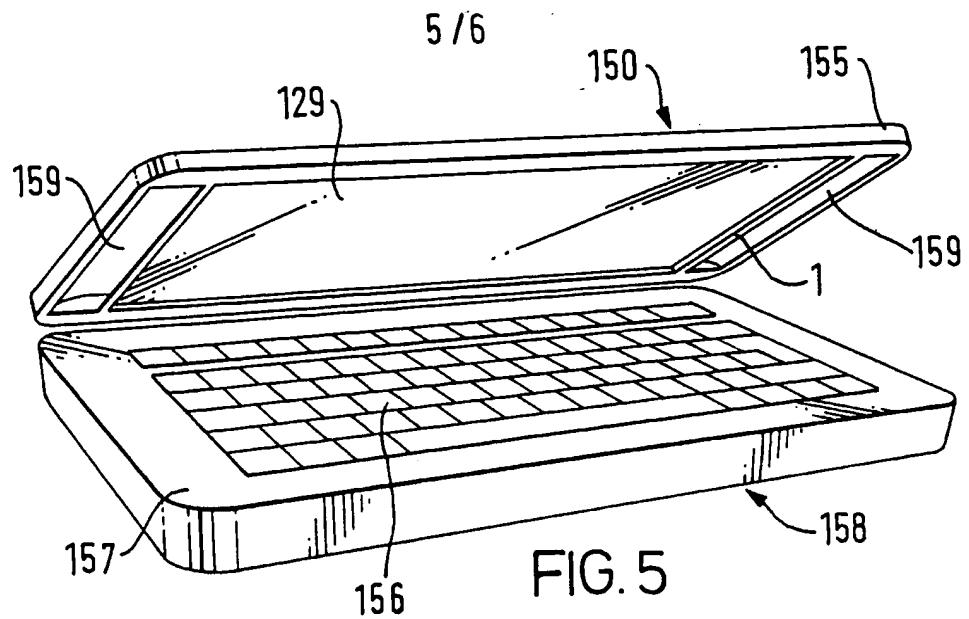


FIG. 4



6 / 6

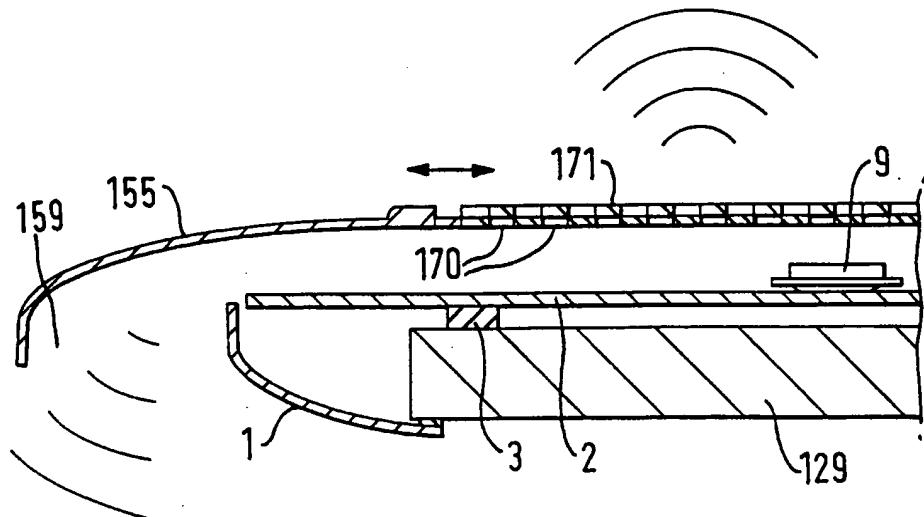


FIG. 5b

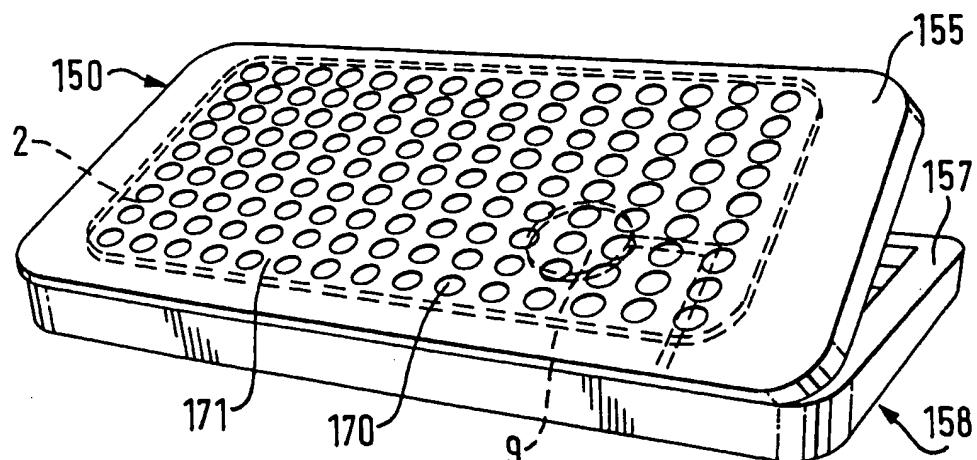


FIG. 6

# INTERNATIONAL SEARCH REPORT

Int. Application No  
PCT/GB 98/00834

**A. CLASSIFICATION OF SUBJECT MATTER**  
IPC 6 H04R1/34 G06F1/16

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)  
IPC 6 H04R G06F H04N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category <sup>a</sup>	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 97 09854 A (VERITY GROUP PLC ;AZIMA HENRY (GB); COLLOMS MARTIN (GB); HARRIS NE) 13 March 1997 see page 4, line 1 - line 7 see page 11, line 9 - page 12, line 12; claims 1,2,5,7,8; figure 3 ---	1,2,5-7, 9,13-15
Y	EP 0 700 210 A (TOKYO SHIBAURA ELECTRIC CO) 6 March 1996 see column 5, line 5 - column 7, line 26; figures 1-4 ---	1,2,5-7, 9,13-15
Y	WO 96 20576 A (PHILIPS ELECTRONICS NV ;PHILIPS NORDEN AB (SE)) 4 July 1996 see page 4, line 20 - page 7, line 18; figures 1-7 ---	1,2,5-7, 9,13-15

Further documents are listed in the continuation of box C.

Patent family members are listed in annex.

<sup>a</sup> Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance  
"E" earlier document but published on or after the international filing date  
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)  
"O" document referring to an oral disclosure, use, exhibition or other means  
"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention  
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone  
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.  
"&" document member of the same patent family

Date of the actual completion of the international search

9 June 1998

Date of mailing of the international search report

26/06/1998

Name and mailing address of the ISA  
European Patent Office, P.B. 5818 Patentlaan 2  
NL - 2280 HV Rijswijk  
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl.  
Fax: (+31-70) 340-3016

Authorized officer

Nieuwenhuis, P

**INTERNATIONAL SEARCH REPORT**

International Application No  
PCT/GB 98/00834

**C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT**

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	PATENT ABSTRACTS OF JAPAN vol. 011, no. 117 (E-498), 11 April 1987 & JP 61 264897 A (MITSUBISHI ELECTRIC CORP), 22 November 1986, see abstract -----	12
P,Y	GB 2 310 559 A (NOKIA MOBILE PHONES LTD) 27 August 1997 see abstract; figure 4 -----	1,2,5-7, 9,13-15

**INTERNATIONAL SEARCH REPORT**

Information on patent family members

 Int'l Application No  
 PCT/GB 98/00834

Patent document cited in search report		Publication date	Patent family member(s)		Publication date	
WO 9709854	A	13-03-1997	AU 6880196 A AU 6880296 A AU 6880396 A AU 6880496 A AU 6880596 A AU 6880696 A AU 6880796 A AU 6880896 A AU 6880996 A AU 6881096 A AU 6881296 A AU 6881396 A AU 6881496 A AU 6881596 A AU 6881696 A AU 6881896 A AU 6881996 A AU 6882096 A AU 6882196 A AU 6882296 A AU 6882396 A WO 9709853 A WO 9709840 A WO 9709841 A WO 9709842 A WO 9709855 A WO 9709856 A WO 9709858 A		27-03-1997 27-03-1997 27-03-1997 27-03-1997 27-03-1997 27-03-1997 27-03-1997 27-03-1997 27-03-1997 27-03-1997 27-03-1997 27-03-1997 27-03-1997 27-03-1997 27-03-1997 27-03-1997 27-03-1997 27-03-1997 27-03-1997 13-03-1997 13-03-1997 13-03-1997 13-03-1997 13-03-1997 13-03-1997 13-03-1997	27-03-1997 27-03-1997 27-03-1997 27-03-1997 27-03-1997 27-03-1997 27-03-1997 27-03-1997 27-03-1997 27-03-1997 27-03-1997 27-03-1997 27-03-1997 27-03-1997 27-03-1997 27-03-1997 27-03-1997 27-03-1997 13-03-1997 13-03-1997 13-03-1997 13-03-1997 13-03-1997 13-03-1997 13-03-1997
EP 0700210	A	06-03-1996	JP 8079659 A CN 1125378 A DE 700210 T US 5710394 A		22-03-1996 26-06-1996 29-08-1996 20-01-1998	
WO 9620576	A	04-07-1996	EP 0746958 A JP 9509817 T US 5737435 A		11-12-1996 30-09-1997 07-04-1998	
GB 2310559	A	27-08-1997	NONE			